Reverse Engineering for Analysis and Design Improvement of Ball Valve Seat

by

Aliff Amirul Hamzah Bin Adenan

Dissertation submitted in partial fulfillment of
the requirements for the
Bachelor of Engineering (Hons)
(Mechanical Engineering)

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Universiti Teknologi PETRONAS
Bandar Seri Iskandar
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Perak Darul Ridzuan

CERTIFICATION OF APPROVAL

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Mechanical Engineering Programme
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TRONOH, PERAK
May 2012

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

ALIFF AMIRUL HAMZAH BIN ADENAN

ABSTRACT

This paper will discuss how to improve seat design for ball valve that is used in oil and gas industry using Reverse Engineering technology. Seat is an important part in the ball valve, since it is utilized to prevent fluid leakage when the valve is fully closed. Today's Reverse Engineering technology are widely used is in diverse applications such as software engineering, manufacturing, aviation industry and consumer products. There are several methods of Reverse Engineering Technology which are Contact method, Noncontact method and Direct Measurement in order to acquire the CAD Model. This project will employ the Noncontact method of Reverse Engineering by using ViuScan 3D Scanning device and Direct Measurement method as contingencies plan. This project are divided into two stages with are Reverse Engineering stage where the ball valve will be scan prior to get the CAD model of the ball valve. The second stages followed where the analysis and design improvement will take place using ANSYS Software, which are Fluent Computational Fluid Dynamic (CFD). As conclusion, Reverse Engineering can shorten the process of analysis of a product in order to enhance or develop a new product.

ACKNOWLEDGEMENT

First and foremost, I would like to take this opportunity to express my greatest appreciation to my Final Year Project supervisor, AP Dr. Ahmad Majdi for his valuable guidance and advices throughout my entire project. His supports, patience, and willingness to assist me in the problem or difficulties that I faced in my project have contributed tremendously to my project. A special thanks goes to Mr. Zamil and other Laboratory Technicians, who has been a great help to me in laboratory works. I also wish to take this opportunity to express my utmost gratitude to the individual and parties that have contributed their time and efforts in assisting me to complete this project, directly or indirectly. Without their helps and assistances, there is no doubt that I would face some difficulties throughout the whole project. This project would not be in success without all of their supports, guidance and patience. I also would like to take this opportunity to thank the Final Year Project coordinator, Dr. Hassan Fawad for his effort in ensuring the project is progressed smoothly within the time frame given. Last but not least, I would like to give my utmost gratitude and appreciation to my family and fellow friends for their support and inspiration so that this project can be completed successfully.

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INTRODUCTION

1.1 Project Background

According to Handbook of Valve Function and Basic Parts that released by Prof. Willow Oguz Salim from Istanbul Technical University, valve is a device that can control the flow of fluid and pressure by starting and stopping the flow of fluid, increased speed of fluid flow by throttling method and also controlling the direction of the fluid[1]. There are several types of valve besides ball valve that are used in oil and gas industry such as gate valve, globe valve, and butterfly valve. All the valves are operates differently and have owns advantages and disadvantages. This project will be focusing on the design of the seat of ball valve that are usually damaged and increase the rate of leakage of the ball valve. Reverse Engineering technology will be adapted in this project to make an improvement from the existing ball valve that currently being used in oil and gas industry nowadays. In general, Reverse Engineering is a process of discovering the technology principle of a mechanical application through analysis of its structure, function and operation.

1.2 Problem Statement

Today's application of Reverse Engineering technology to analyze the existing product in order to made improvement as long as to speeding up the production have gained momentum in recent years. This project will adapt Reverse Engineering technology to analyze the design of seat in the ball valve that used in oil and gas industry. The typical used of ball valve in oil and gas industry are often related to harsh environment such as high temperature, high pressure and also operated at lower temperature and cryogenic application such as in transportation Liquefied Natural Gas (LNG). In order to perform the operations, the ball valve that being used must be afford to open and closed the flow of fluid without leakage.

The internal part in the ball valve that is important to avoid leakage other than spherical ball inside the valve is a seat. Seat is the internal part in the ball valve that are used to hold the ball when the valve in closed position. There are two typed of seat that currently being used in the ball valve, which are metal seated and soft seated. The typical problems that contribute to leaking are alignment of the seat and ball with the internal wall of the valve [2]. A little misalignment between the seat and the ball will make a space that contribute to leakage when the valve in closed position. This occurs when the seat are having deformation. Besides, an erosion also occur when the ball valve are partially open or close. The impingement of the high speed flow of fluid will damage the seat and also the ball. Since ball valve are typically been used to carry a crude oil, the material used in constructed the seat also contributed the leakage. For example, the metal seated will experience scratch and pitting as the crude oil contains abrasive particles that can damage the surface of the seat and also the ball. These kinds of action also shorten the life of the seat.

1.3 Objective

The objectives of this project are:

- Use Reverse Engineering technology to analysis and made further improvement to the seat design.
- To determine the effect of fluid flow to the seat design of ball valve by conducting Computational Fluid Dynamic (CFD) analysis.
- To determine maximum seat deformation when subjected to pressure using Static Structural analysis.
- To propose new design and material that can enhance the valve sealing capability.

1.4 Scope of Work

This project is research and analysis based that emphasize on improvement of the ball valve seat design for oil and gas application. This project will focus on using Reverse Engineering technology in order to achieve a better seat design for ball valve. The project will be accomplished in two parts, FYP 1 and FYP 2. In FYP 1, all the mechanism and material used in construction the current ball valve that being used in oil in gas industry in detailed will be determined. For this part, it required the ball valve that currently used in oil and gas industry to study in the detail all the design and the material being used in construction the ball valve. In FYP 2, the Reverse Engineering stages will commence where the ball valve will be scanning to the CAD drawing. Then, the Finite Element Analysis (FEA) will be done using ANSYS for its mechanical properties and using Computational Fluid Dynamic (CFD) to analysis the fluid flow inside the ball valve.

CHAPTER 2

LITERATURE REVIEW

2.1 Reverse Engineering Technology

Engineering can be defined as the process of designing, manufacturing, assembling and maintaining product and systems. Vinesh Raja and Kiran Jude Fernandes, in their book stated that engineering can be classified into two categories, which is forward engineering and reverse engineering [3]. Forward engineering also known as traditional engineering is the process to transforms engineering concepts and model into real parts [3]. Reverse Engineering as it name implied is the process of duplicating an existing component, subassembly, or product, without the aid of drawings, documentation, or computer model [4]. The process sometimes involves taking something apart and analyzing its working in detail, usually with the intention to construct a new device or program that does the same thing without applying anything from original.

The general process of Reverse Engineering is examined how the component work rather than examined why it is designed. This kind of method allowed us to study about the technology that is used in order to make further improvement. Reverse engineering is very common in such diverse fields as software engineering, aviation industry, automotive, consumer products, and mechanical designs.

There are several reason why Reverse Engineering is widely use today, such as the original manufacture of a product is no longer produce the product, to explore the ways to enhance the product or component performance and features that will be focusing in this project. Besides, Reverse Engineering also used to gain competitive benchmarking methods to understand competitor's products and develop a better product.

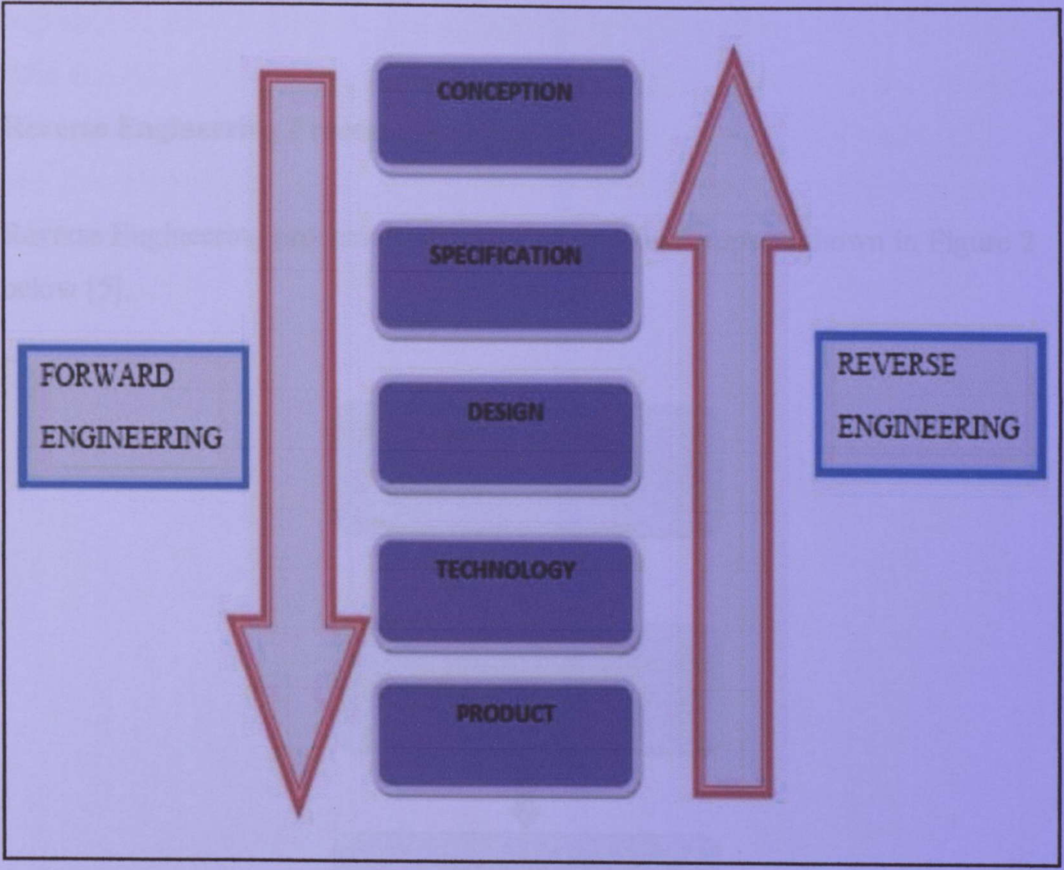


Figure 1: Differential between Forward Engineering and Reverse Engineering

2.2 Reverse Engineering Process

Reverse Engineering process can be divided into four steps as shown in Figure 2 below [5].

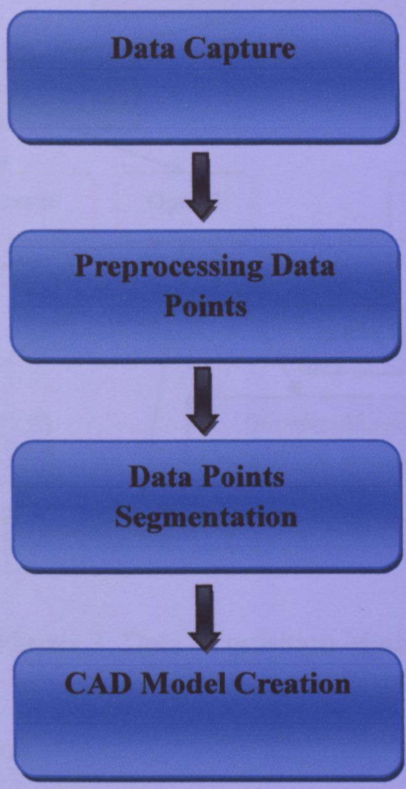


***Figure 2**: Phases of Reverse Engineering*

The first step in Reverse Engineering is to generate conceptual model based from physical model. The process of capturing data from physical model is achieved using 3D Scanner also known as data acquisition. There are two methods of data acquisition which are tactile (contact) and noncontact method [5].The further explanation of the data acquisition methods is illustrated in Figure 3. During the scanning process, the 3D Scanner either contact or noncontact will move back and forth across the physical model and the system will records information about the surface that can vary from point clouds to complete boundary representation (B-Rep) model. A point cloud is a set of vertices in a three-dimensional coordinate system. These vertices are usually defined by X, Y, and Z coordinates, and typically is intended to be representative of the external surface of an object [6].

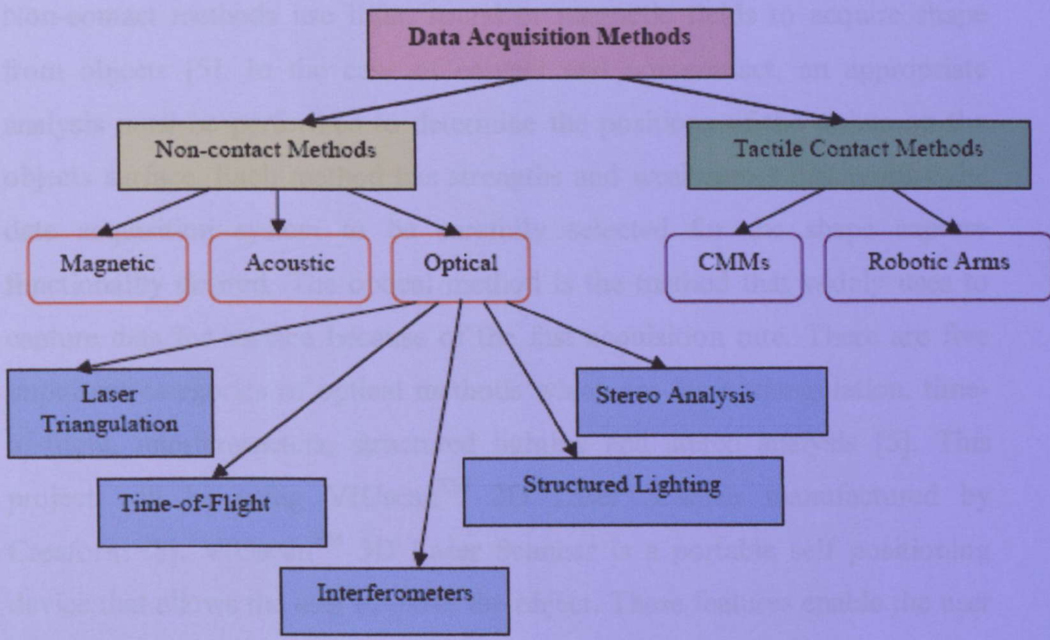


Figure 3: Data Acquisition Methods

2.2.1 Tactile Contact Method

The Tactile or Contact method is most popular approach to shape capture since it useful for inspection purpose due to high accuracy [7]. Coordinate Measuring Machines (CMMs) and robotic arms with a touch probe sensing device are the example of 3D device that being used in Tactile method. CMMs are often used when high precision is required. It is considered a contact type method that is Numerical Control-driven and can program sampling of points for predefined features efficiently [7]. CMMs are very accurate and nearly noise-free when collecting data from the object surface due to it can be programmed to follow the path along the object surface. A part from that, there a several disadvantages when using CMMs such as, slow to capture data and also can damaged the surface of the soft object [7].

2.2.2 Non- Contact Method

Non-contact methods as its name suggested, is a method where the scanner had no contact with the physical object to obtain the point of clouds. Non-contact methods use light, sound or magnetic fields to acquire shape from objects [5]. In the case of contact and non-contact, an appropriate analysis must be performed to determine the positions of the points on the objects surface. Each method has strengths and weaknesses that require the data acquisition system to be carefully selected for the shape capture functionality desired. The optical method is the method that widely uses to capture data for surface because of the fast acquisition rate. There are five important categories of optical methods which are laser triangulation, time-of-flight, interferometers, structured lighting and stereo analysis [5]. This project will be using VIUscan™ 3D Laser Scanner manufactured by Creaform [8]. VIUscan™ 3D Laser Scanner is a portable self positioning device that allows the user to move the object. These features enable the user to get accurate surface data.

Figure 4: VIUscan™ 3D Laser Scanner

There are several problems occur during data acquisition which is [9]:

Problem	Explanation
Calibration	Occur when setting up the measuring device. The measuring device should be calibrated first to get an accurate data.
Accessibility	Occur because of the configuration or topology of the parts. Required multiple scanners to acquire the data such a part that have hole.
Occlusion	Occlusion is the blocking of the scanning medium due to shadowing or obstruction. Required more than one scanner to solve the problem.
Fixturing	Fixturing can be classified as occlusion. The physical object typically must be clamped before scanning, and this result to the fixture image also being scanned with the physical object.
Surface Finish	Smoothness and material coating on the physical object will bring a problem during data acquisition. The rough surface will produce more noise when using both method data acquisition.

Table 1: Data acquisition problems

The second step in Reverse Engineering is preprocessing data point. The preprocessing data required three steps which are filtering, smoothing, and reduction of data [10]. Filtering process need to be done in order to removed noisy point to prevent error in the surface generation [11]. Preprocessing step take care the acquired data for segmentation and surface fitting. After done the preprocessing step, the segmentation and surface finish take place. The process of divided each point into subset is called segmentation. Every divided subset only contain those point sampled from a particular natural surface [12].Then, the surface type of each subset will be classified such as planar, cylindrical or others. The surface fitting is a process where the surface type will be fit to each subset accordingly. There is several method of segmentation which is Edge Based, and Region Based or Face Based [12].

2.3 Ball Valve Design Overview

Valve is a device that can control the flow of fluid and pressure by starting and stopping the flow of fluid, increased speed of fluid flow by throttling method and also controlling the direction of the fluid [1]. A ball valve is a rotational motion valve that uses a spherical disc to stop or start the flow of fluid. The sphere has a hole or port through the middle. When the valve handle is turned to open the valve, the sphere will rotates to a point where the hole through the sphere or ball will in line with the valve inlet and outlet that result the fluid flow through the valve.

The flow-control characteristic that arises from a round port moving across a circular seat and from the double pressure drop across the two seats is very good. However, if the valve is left partially open for an extended period under conditions of a high pressure drop across the ball, the soft seat will tend to flow around the edge of the ball orifice and possibly lock the ball in that position. Ball valves for manual control are therefore best suited for stopping and starting flow and moderate throttling. If flow control is automatic, the ball is continuously on the move, thus keeping this failure from normally occurring [13]. The ball moves across the seats with a wiping motion, ball valves will handle fluids with solids in suspension. However, abrasive solids will damage the seats and the ball surface.

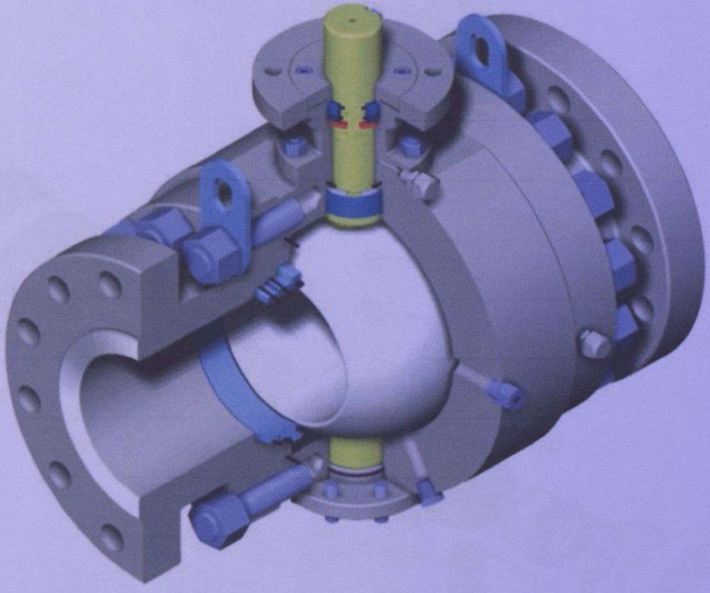
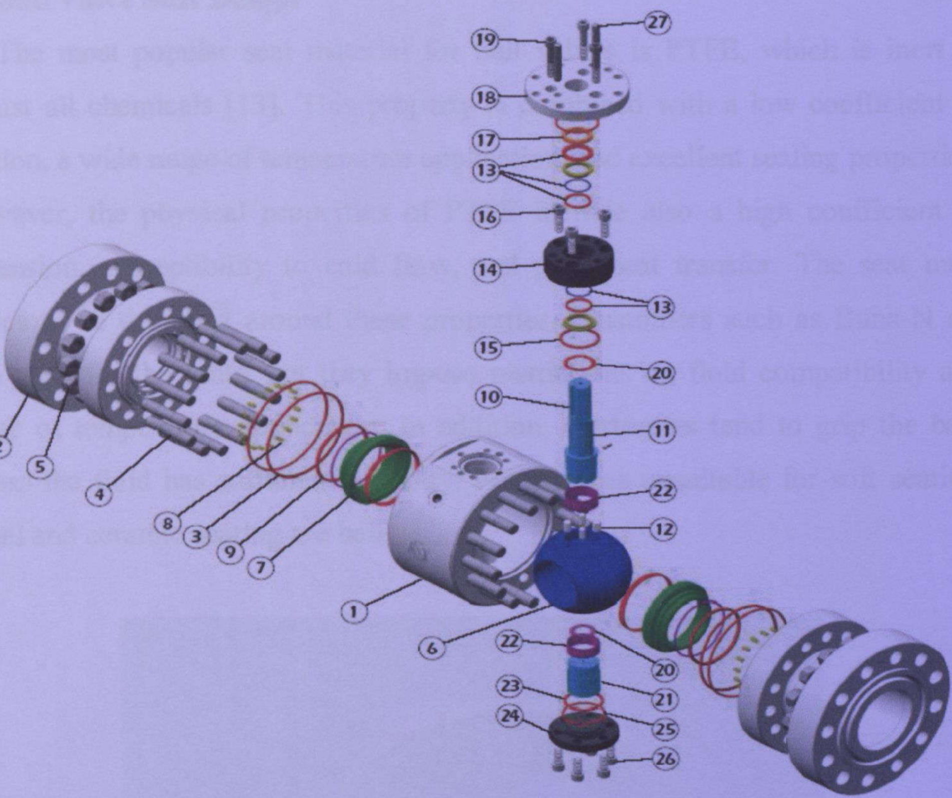


Figure 5: Trunnion ball valve



Trunnion Design

1. Body	10. Stem	19. Capscrew
2. Closure	11. Key	20. Thrust Washer
3. Gasket	12. Drive Pin	21. Trunnion
4. Body Stud	13. Gasket	22. Bearing
5. Body Nut	14. Body Cover	23. Gasket
6. Ball	15. Gasket	24. Trunnion Cover
7. Seat Ring	16. Capscrew	25. Gasket
8. Seat Spring	17. Bushing	26. Capscrew
9. Gasket	18. Adapter Flange	27. Dowel Pin

Figure 6: Exploded view of Trunnion ball valve

2.4 Ball Valve Seat Design

The most popular seat material for ball valves is PTFE, which is inert to almost all chemicals [13]. This property is combined with a low coefficient of friction, a wide range of temperature application, and excellent sealing properties. However, the physical properties of PTFE include also a high coefficient of expansion, susceptibility to cold flow, and poor heat transfer. The seat must therefore be designed around these properties. Elastomers such as Buna-N are also used for the seats, but they impose restrictions on fluid compatibility and range of temperature application. In addition, elastomers tend to grip the ball, unless the fluid has sufficient lubricity. For services unsuitable for soft seating, metal and ceramic seating are being used.

Figure 7: PTFE Seat design

CHAPTER 3

METHODOLOGY

3.1 Research Methodology

In order to make realization of this project, the main objectives highlighted in the Chapter 1 need to be accomplished. Apart of that, gaining understanding of the project must be done in order to make sure the project's progress work smoothly according to plan.

Thorough research and literature review will be undertaken through the selected and related journal papers and books that including detailed analysis involving data and information gathering that only concentrated on the Reverse Engineering including ball valve design and mechanism in detail.. The relevancy between selected papers, books and project objectives need to be taken into account to ensure the credibility of the project.

Next, development of the CAD model of the original ball valve is done accordingly. The modification process to enhance the seat design will be done using Computational Fluid Dynamic (CFD) to ensure the reliability of the improved seat design.

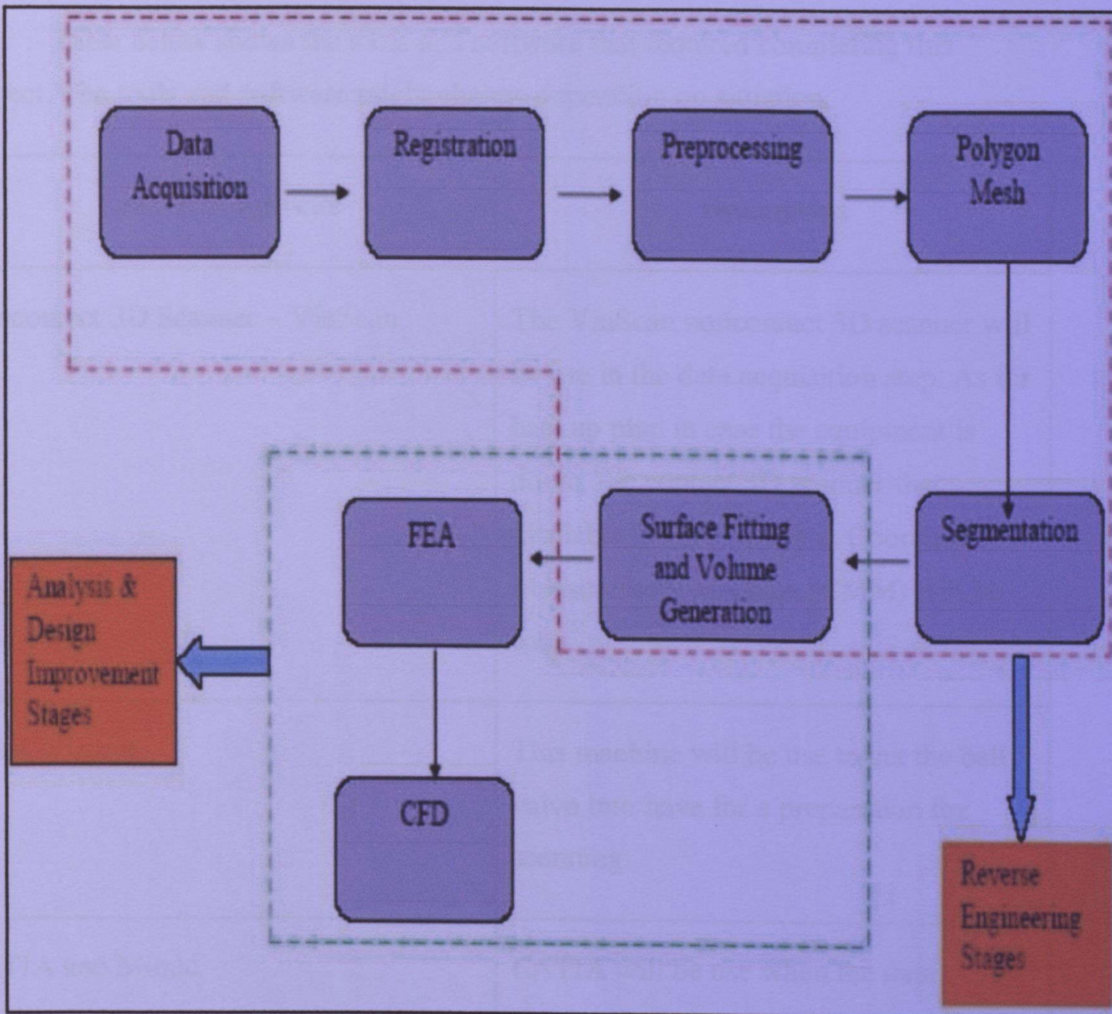


Figure 8: Project Methodology

3.2 Tools and Software Required

Table below shows the tools and software that required completing this project. The tools and software might change depending on situation.

Tools and Software	Description
Noncontact 3D Scanner – ViuScan	The ViuScan noncontact 3D scanner will be use in the data acquisition step. As for backup plan in case the equipment is down, the contact 3D scanner that available in UTP which is Coordinate Measurement Machine (CMM) will be use.
EDM Wirecut	This machine will be use to cut the ball valve into have for a preparation for scanning.
CATIA and Mimic	CATIA will be use when the data acquisition is done. The point cloud that was obtained during data acquisition will be interpreted using CATIA to generate surface. Mimic software will take place to complete the meshing and volume generation.
ANSYS	When the volume mesh is done, ANSYS software will take place for Finite Element Analysis (FEA) and also Computational Fluid Dynamic (CFD)

Table 2: Tools and Software required

3.3 Activities/Gantt Chart and Milestone for FYP 1

No	Detail/Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Selection of Project Topic: Reverse Engineering for Analysis and Design Improvement														
2	Preliminary Research Work: Research on literatures related to the topic														
3	Submission of Extended Proposal														
4	Project Work: Study on the research scope and method														
5	Viva: proposal defense and progress evaluation														
6	Project work continues: • Meeting with Valser Oil and Gas Sdn Bhd • Familiarizing with 3D Scanner and Design Software (CATIA, ANSYS, Mimic)														
7	Draft for final report														
8	Submission of Interim Report Final														

No	Detail/Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Familiarizing with Design Software (CATIA & Mimic)														
2	Acquire part for scanning - Valser Ball Valve														
3	Dismantle Ball valve to study the mechanism														
4	EDM Wirecut Ball valve to be ready for scanning														

Table 3: FYP 1 Gantt chart and Key Milestone

3.4 Activities/Gantt Chart and Milestone for FYP 2

No	Detail/Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Reverse Engineering development														
2	CFD Analysis of the Ball Valve														
3	Discussion and analysis on the simulation result obtained.														
4	Produce a Final Report														

No	Detail/Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Completion of ball valve fluid flow simulation										●				
2	Completion of discussion and analysis on the simulation results obtained.												●		
3	Completion and submission of final report														●

Table 4: FYP 2 Gantt chart and Key Milestone

CHAPTER 4: RESULT AND DISCUSSION

The very first steps before proceed to the Reverse Engineering process is analyzing the ball valve that were obtained. The ball valve was being dismantled into each part to enable the study of the mechanism that occurred in the ball valve itself. After carefully study each part of the ball valve as shown in the Figure 10, all the parts of the ball valve was assemble back into one piece before proceed to the next steps which is cutting the ball valve into half symmetry.

The ball valve was cut into half using Wirecut Electric Discharge Machine (EDM Wirecut) with the helps from lab technician. The purpose of the cutting process is to get the clear view of all the parts in the ball valve without dismantle it. Beside, this also help to measure all the parts accurately using vernier caliper as part of Reverse Engineering process which is same as scanning the product.

4.1 Ball Valve Technical Specification

- ½ inch Ball valve size for water/oil/gas application
- Padlocking device
- Body: Stainless Steel 316 (SS316)
- Stem: Stainless Steel 316 (SS316)
- Seat: Polytetrafluoroethylene (PTFE)
- End Connections : Threaded Ends Ball valve
- Working Pressure: 1000 psi
- Temperature Range: -50° F to 400° F
- Test Standard and Specification: API 598 and API 6D

4.2 Reverse Engineering Development Process

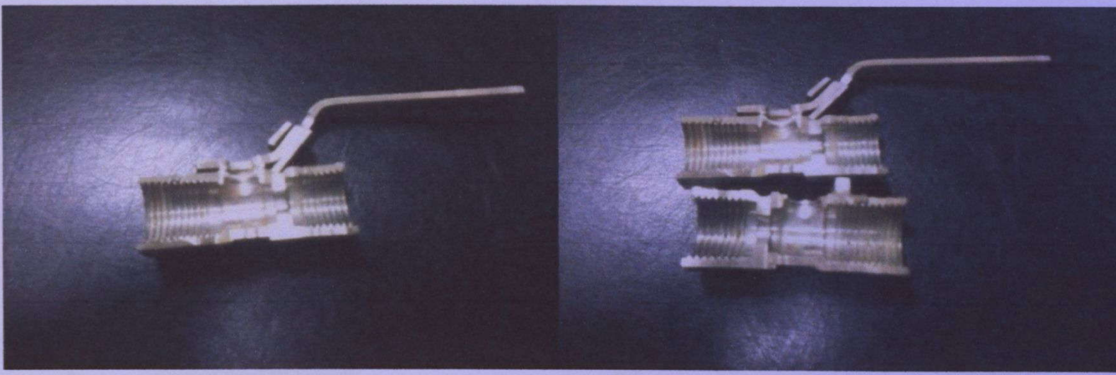


Figure 9: EDM Wirecut product

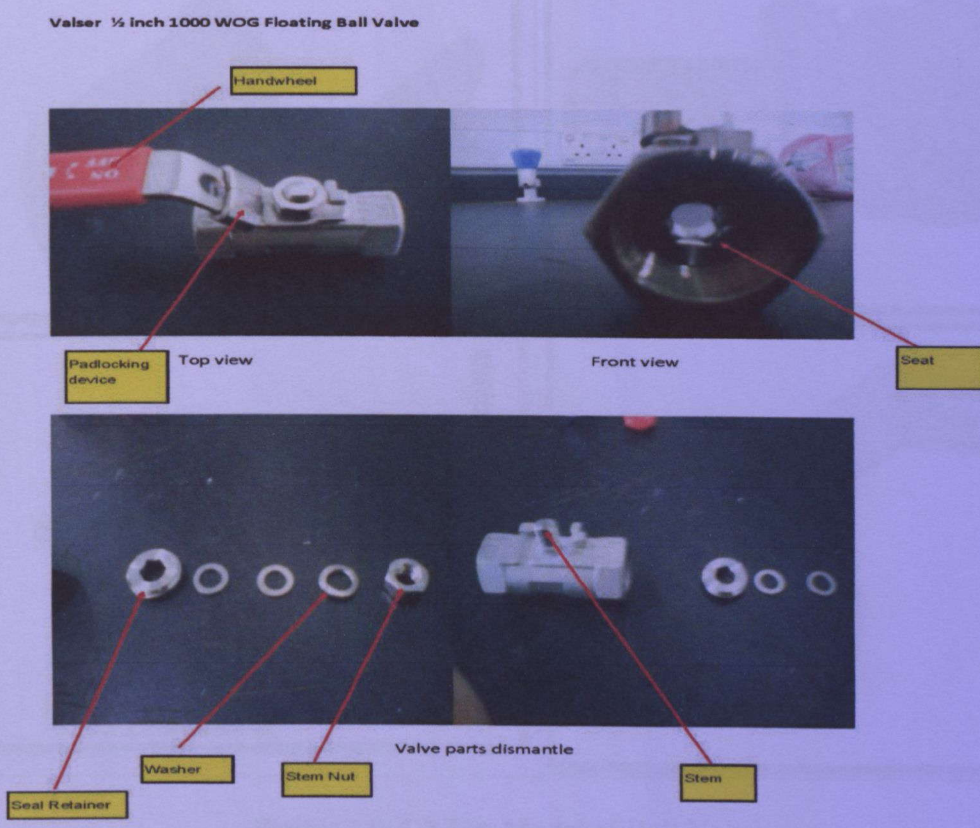


Figure 10: Ball valve Dismantle process

The CAD model of the ball valve was obtained by using Direct Measurement Method of Reverse Engineering. All the measurement was entered into CATIA software to develop the CAD model of ball valve as shown in Figure 11.

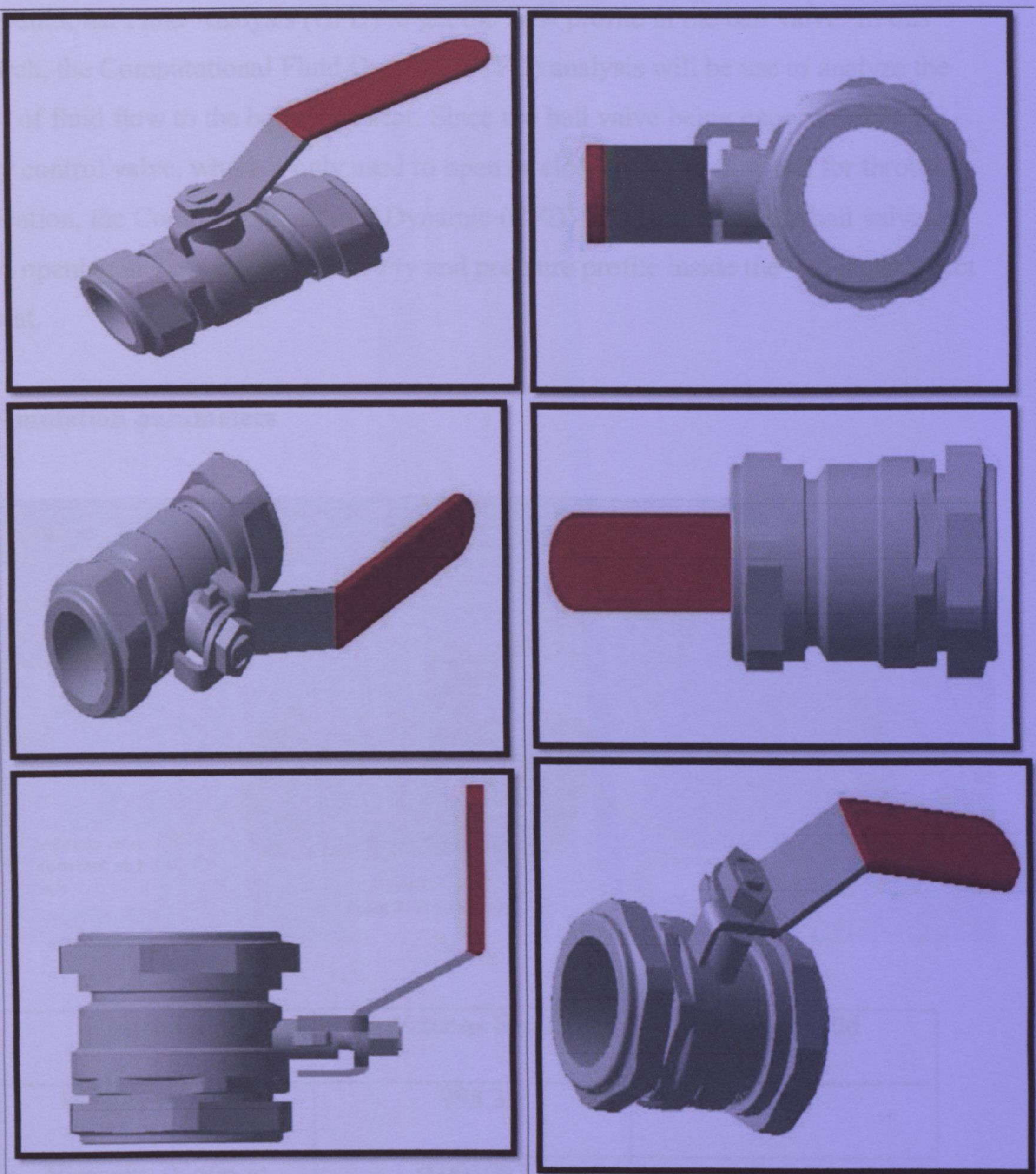
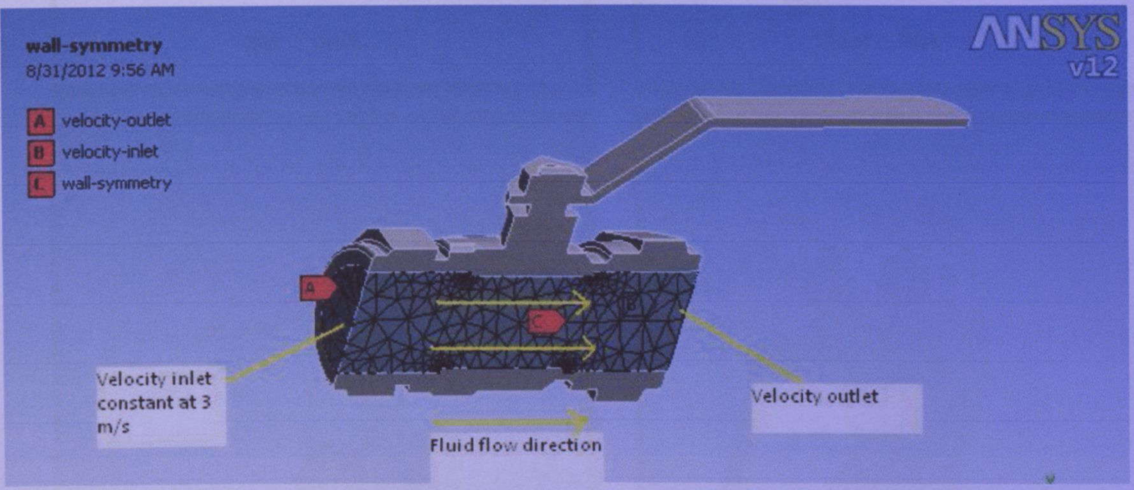


Figure 11: CATIA Model of Ball Valve

Figure 12 has shown the CAD model of ball valve during meshing operation. This operation was done by using ANSYS Software as the first steps of analyzing the ball valve. After completed this meshing process, the CAD model can be available for Computational Fluid Analysis (CFD) to get the flow profile in the ball valve. In this research, the Computational Fluid Dynamic (CFD) analysis will be use to analyze the effect of fluid flow to the ball valve seat. Since the ball valve being experimented is a safety control valve, where it only used to open or close the fluid flow not for throttling application, the Computational Fluid Dynamic (CFD) will be done to the ball valve at 100% opening and obtained the velocity and pressure profile inside the valve that affect the seat.

4.3 Simulation parameters



Material	Water as liquid	Steel as solid
Density (Kg/m^3)	998.3	8030
Viscosity (Kg/m-s)	0.001003	-

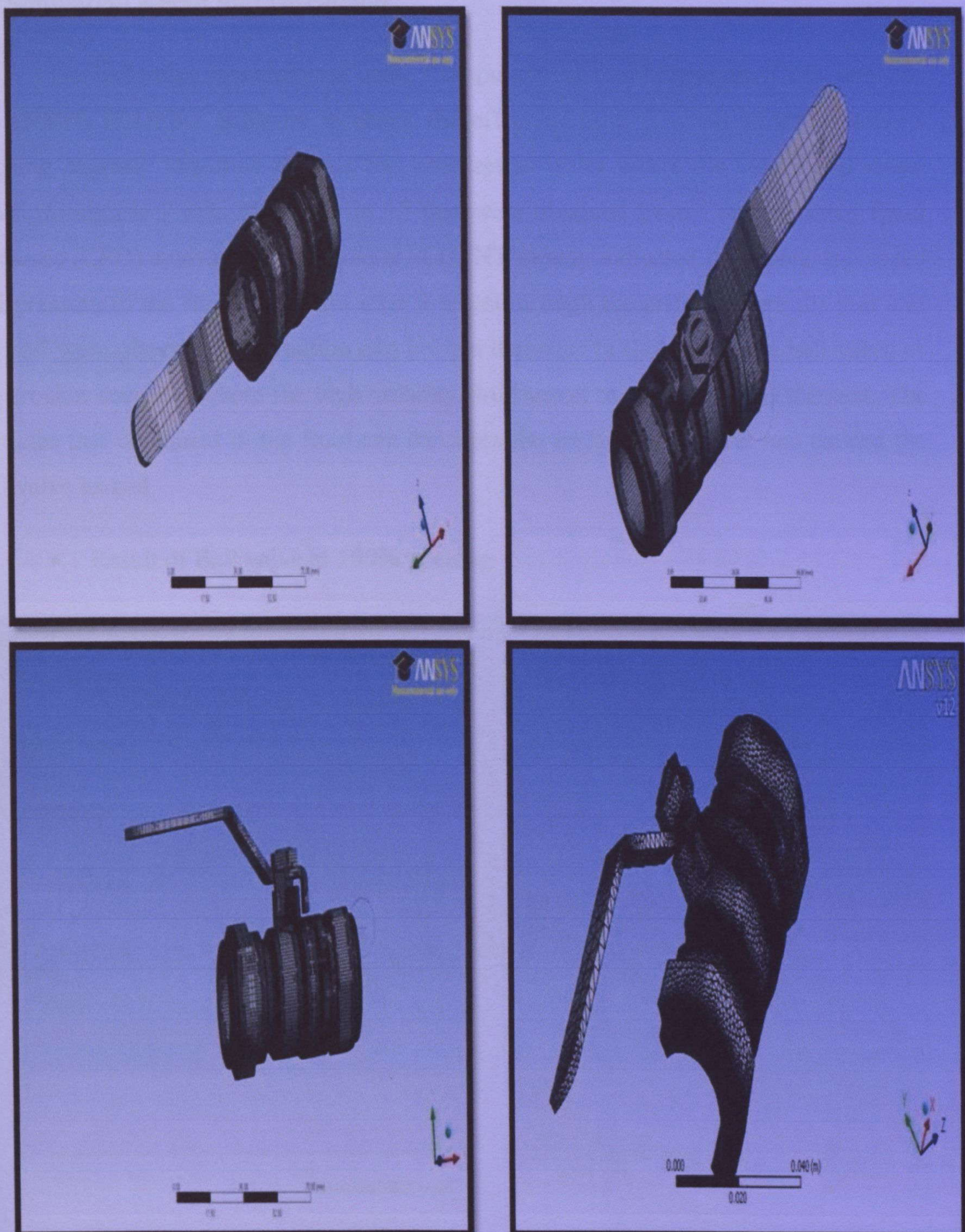


Figure 12: Meshed Ball Valve

4.4 Simulation Result and Discussion

The ball valve was analyzed using Computational Fluid Dynamic (CFD) analysis by ANSYS FLUENT software to check the effect of fluid flow on variation valve's opening degrees. The fluid domain has been set to water where the velocity of water travel through is 3 m/s. Figure 13 to 17 that were obtained from Computational Fluid Dynamic (CFD) analysis using ANSYS FLUENT clearly indicated the increasing speed and pressure of the fluid flow right after it travel through the orifice where the seat and the ball were placed. This situation can bring a damages to the seat of the ball valve as the erosion occurred where the high velocity fluid travel to the surface of the seat. The particles that contained in the fluid can damages the surface of the seat and caused the ball valve leaked.

- Result of Ball valve at 100% opening

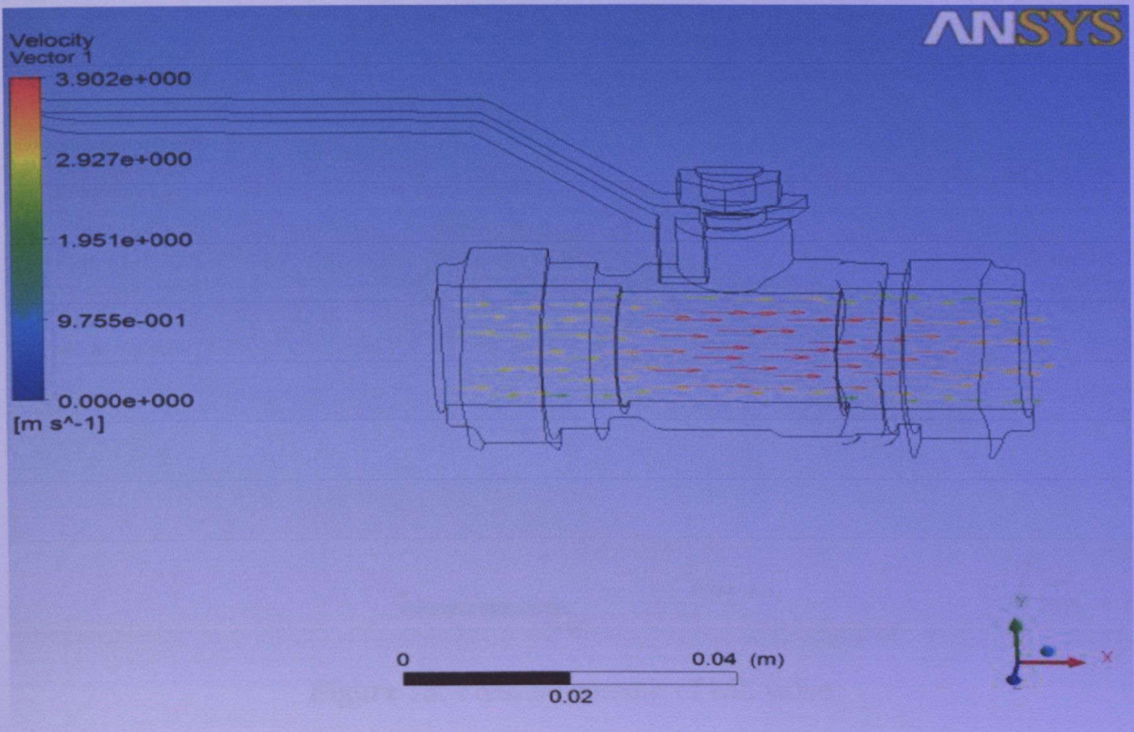


Figure 13: Velocity vector of ball valve

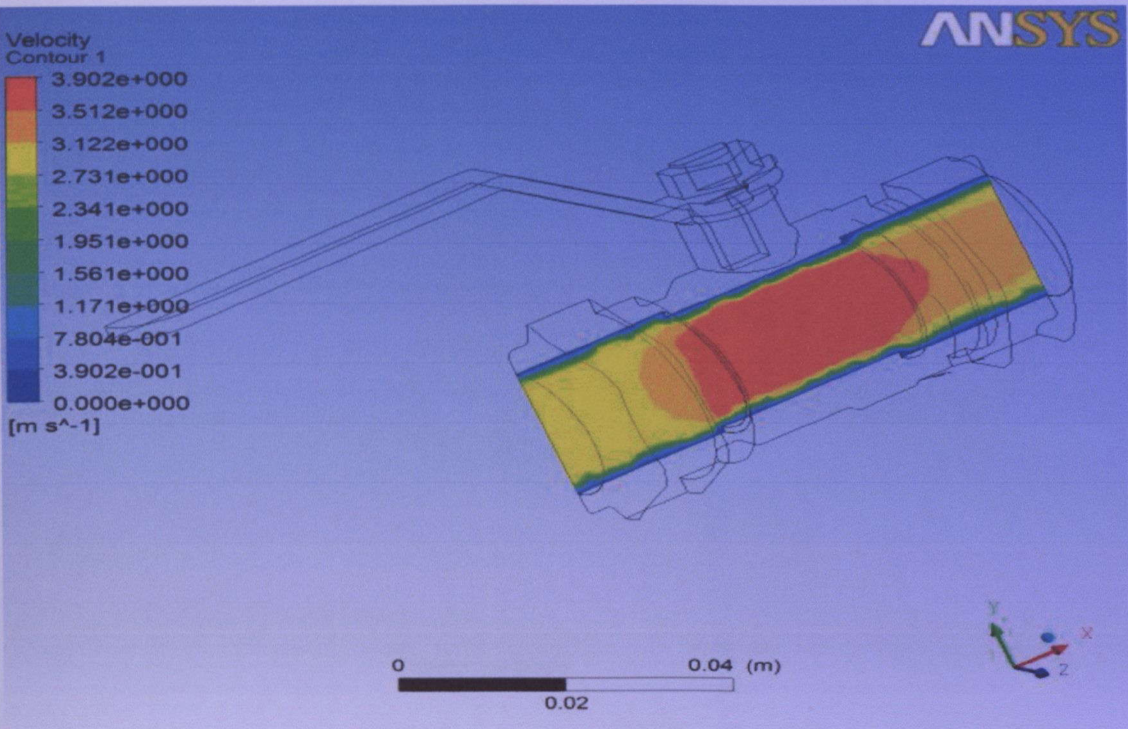


Figure 14: Velocity contour of ball valve

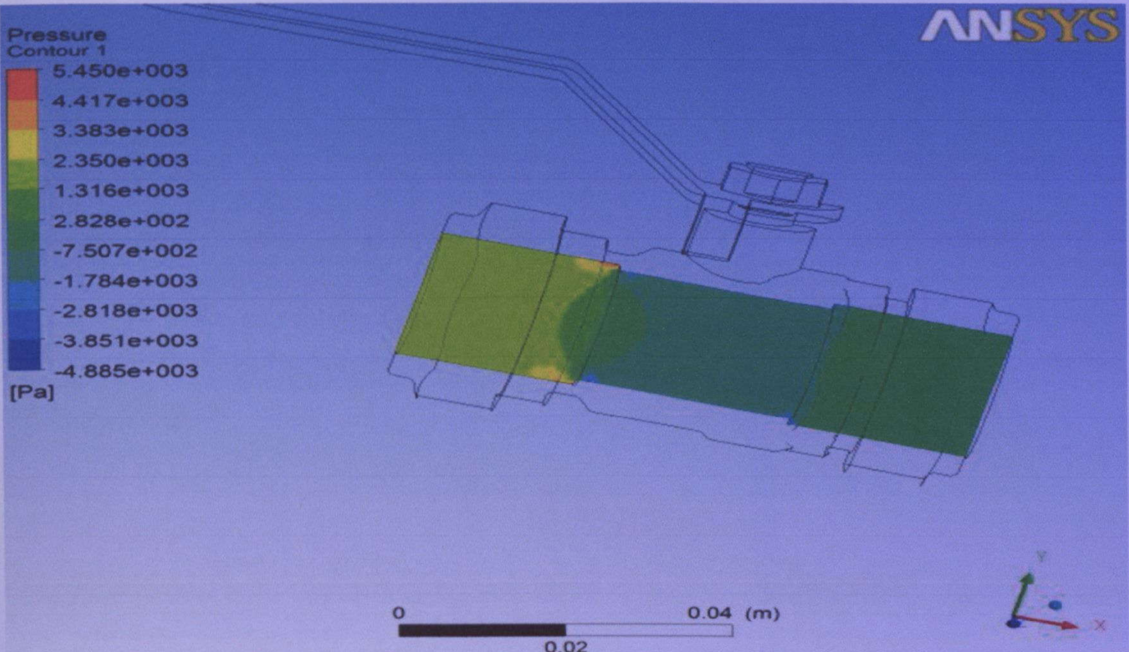


Figure 15: Pressure contour of ball valve

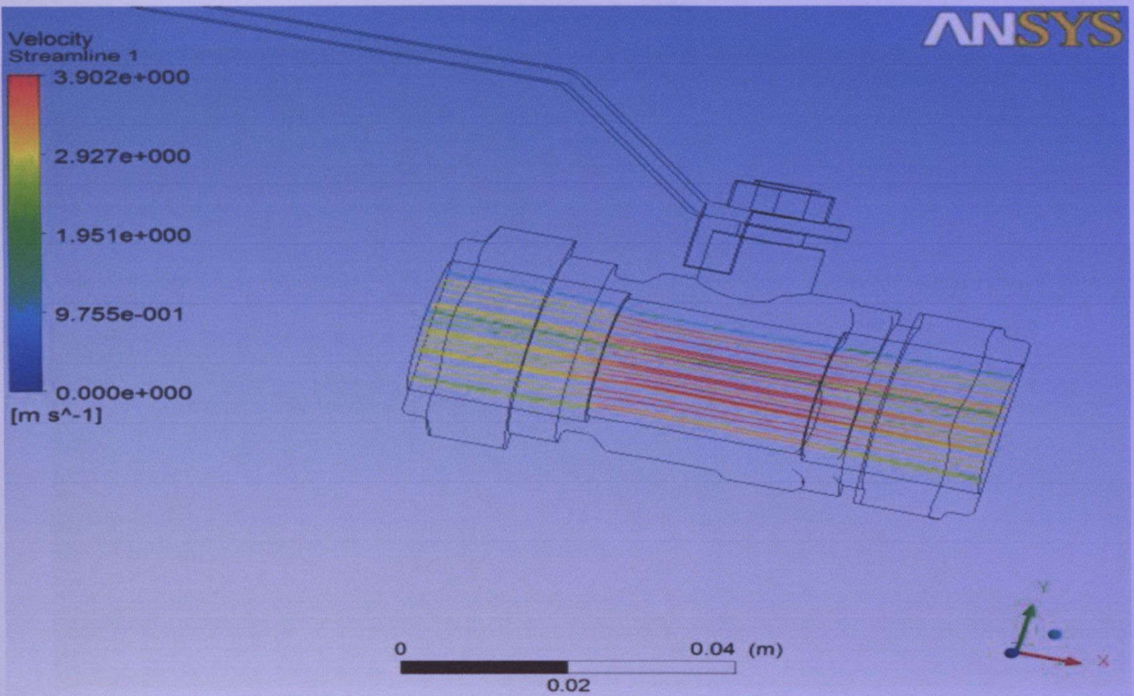


Figure 16: Velocity streamline #1 of ball valve

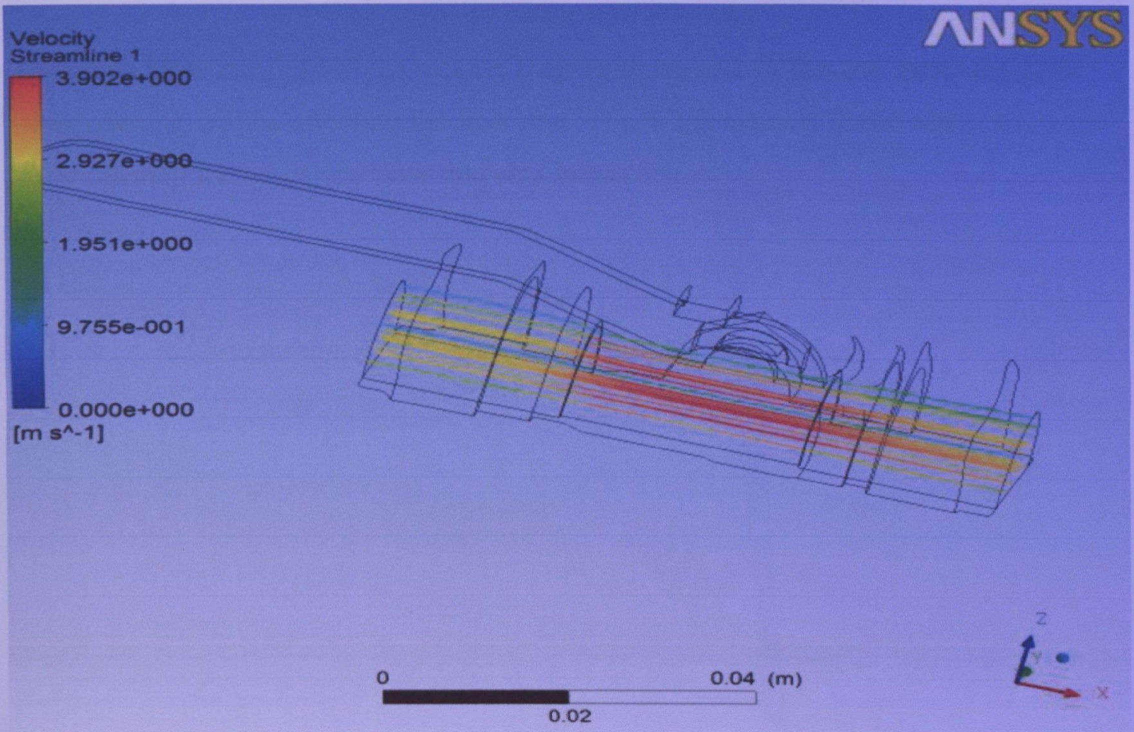


Figure 17: Velocity streamline #2 of ball valve

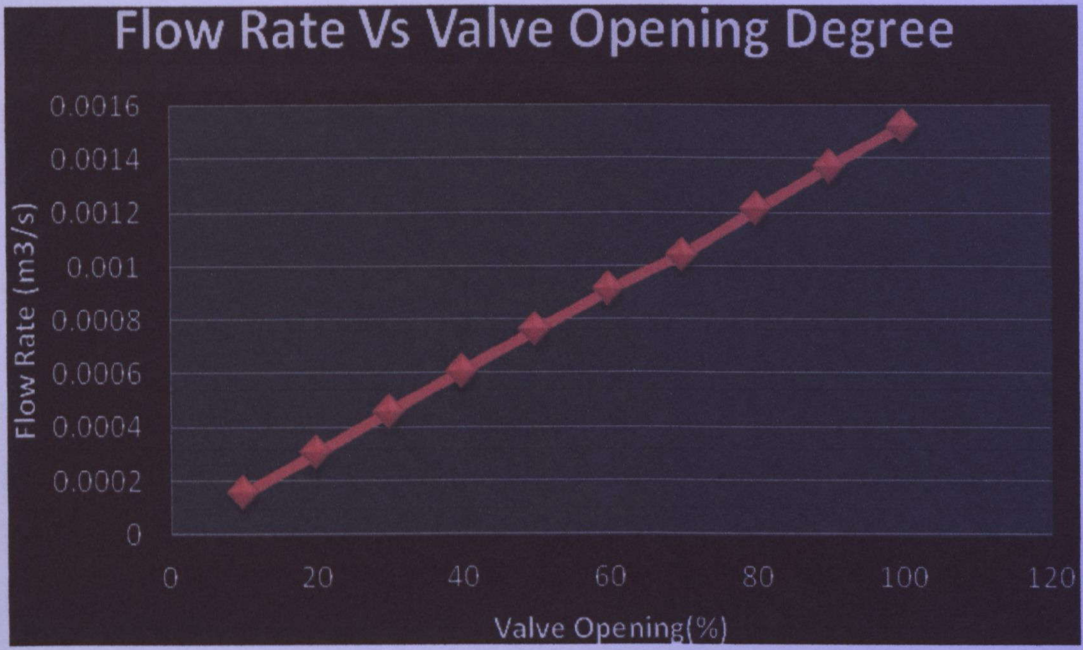


Figure 18: Flow Rate Vs Valve Opening Degree

The graph Flow rate Vs Valve Opening Degree above shown that the increases of the valve opening will be affecting the flow rate. The relationship is linear where when the valve opening increases, the flow rate also increasing.

In order to validate the result obtained from the analysis of the ball valve, the seat of the ball valve were analysis using the same method to see clearly the effect of fluid flow the seat itself. As shown in Figure 19 to 23, it's proved that the high velocity and pressure occurred around the seat as the fluid travel through it. The increasing in speed as the fluid travelled through the seat as shown in Figure 19, will resulted the seat to damage as the erosion occurred.

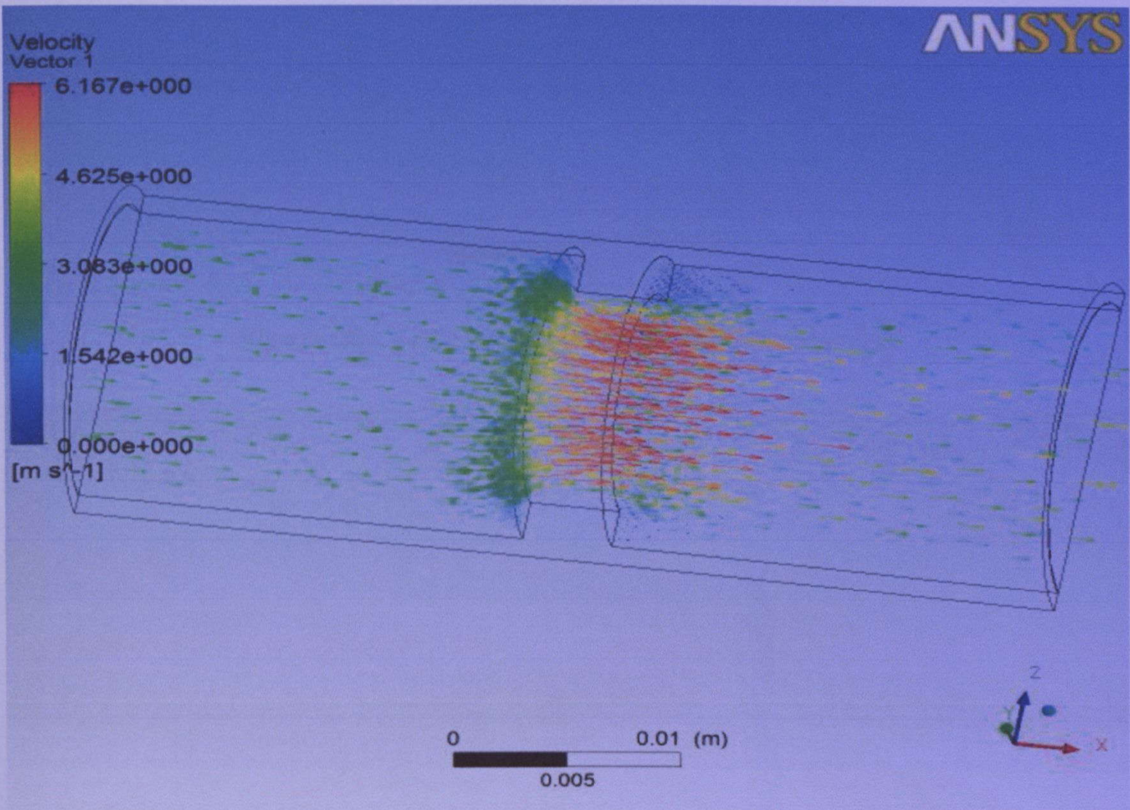


Figure 19: Velocity vector of the seat

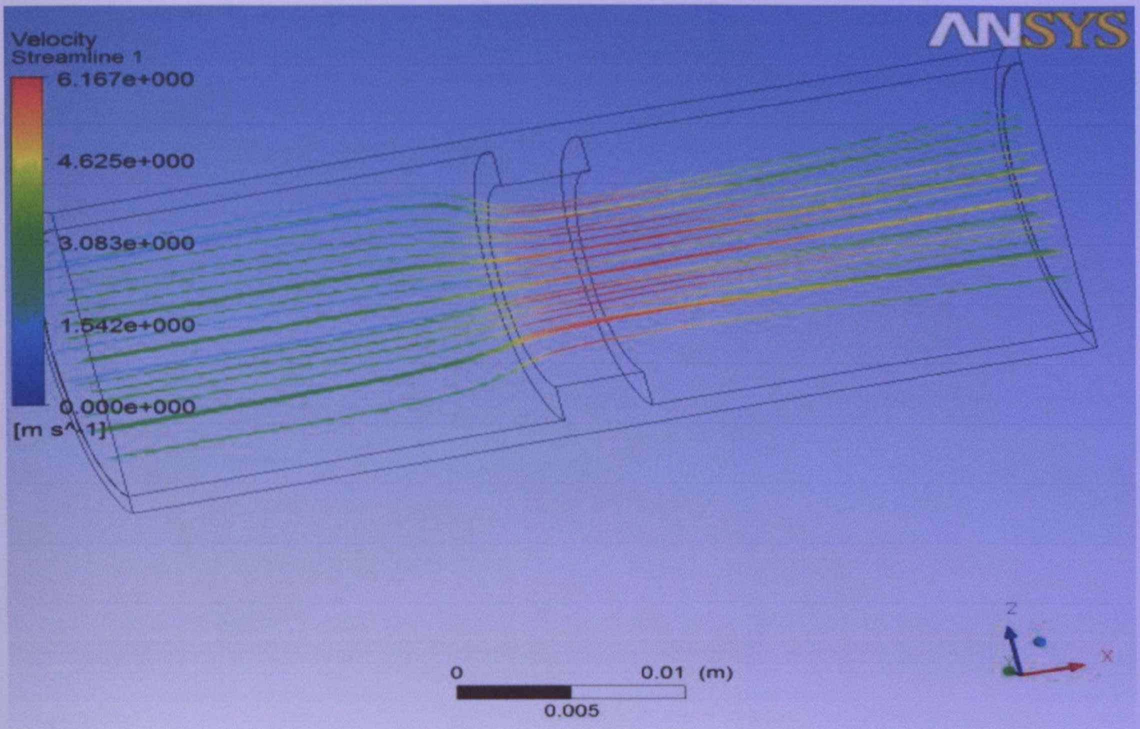


Figure 20: Velocity streamline #1 vector of the seat

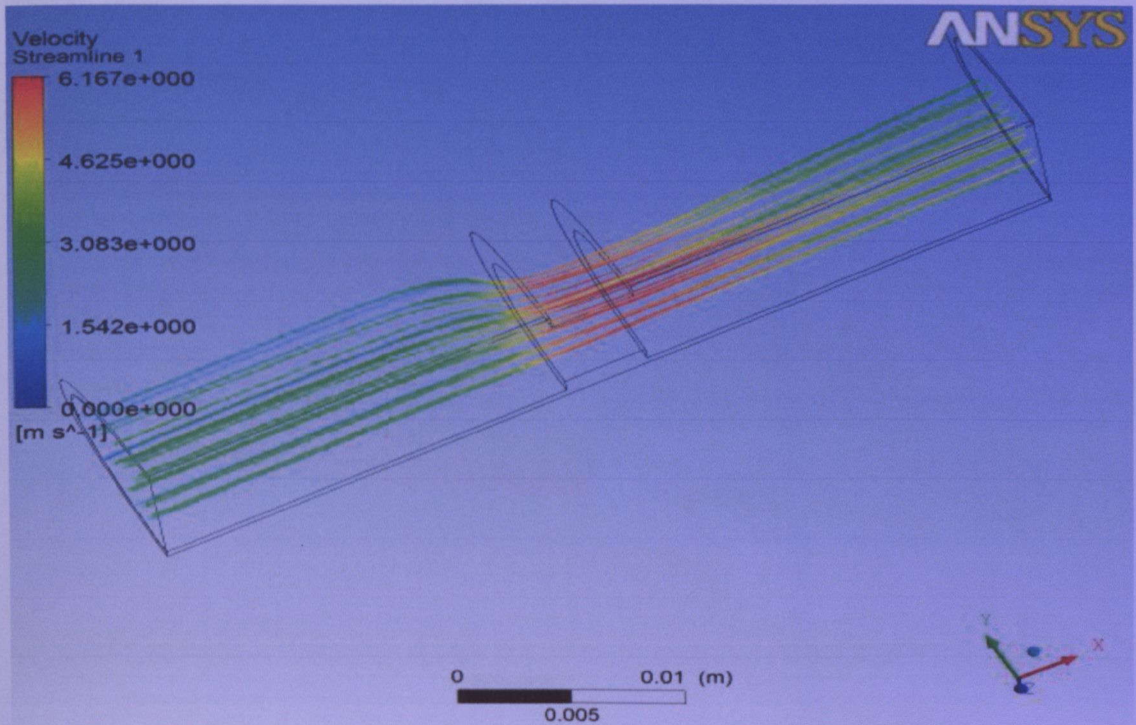


Figure 21: Velocity streamline #2 of the seat

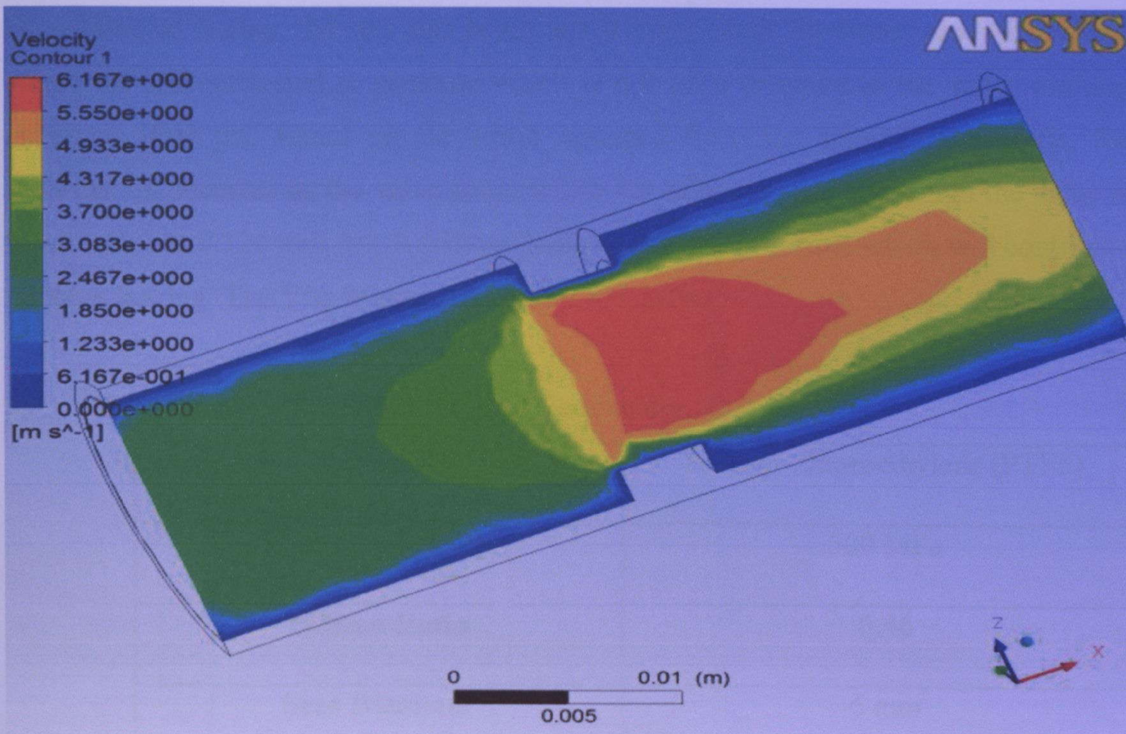


Figure 22: Velocity contour of the seat

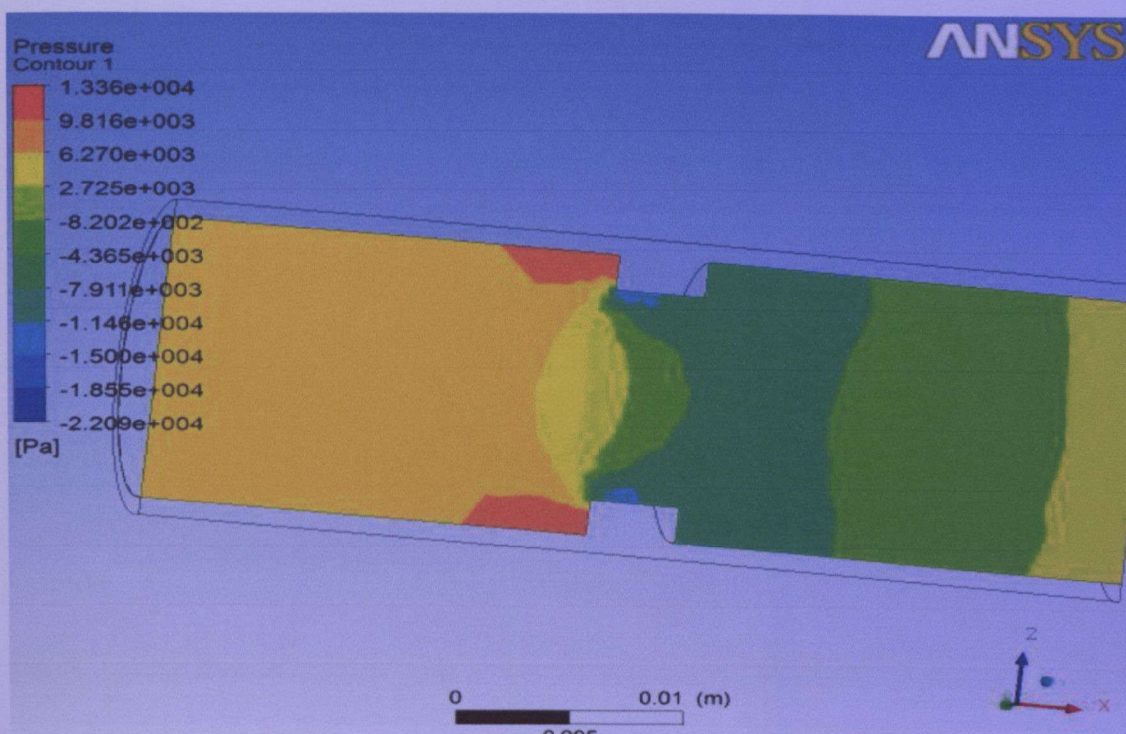


Figure 23: Pressure contour of the seat

For additional testing, the seat also being tested using Static Structural analysis method where the seat subjected to pressure which is 6.9 MPa or equal to the valve working pressure, 1000 psi. Based on the result obtained from the simulation analysis, the deformation occurred as the valve subjected to 6.9 MPa pressure. Although the value is small which is 0.124 mm, but is will gradually increases over time which will contribute to valve leaking. The Von Misses stress is 50.875 MPa.

- Seat Static Structural Analysis Parameters

Material	Polytetrafluoroethylene (PTFE)
Young's Modulus	500 MPa
Poisson Ratio	0.46
Seat Diameter	6 mm
Pressure Subjected	6.9 MPa

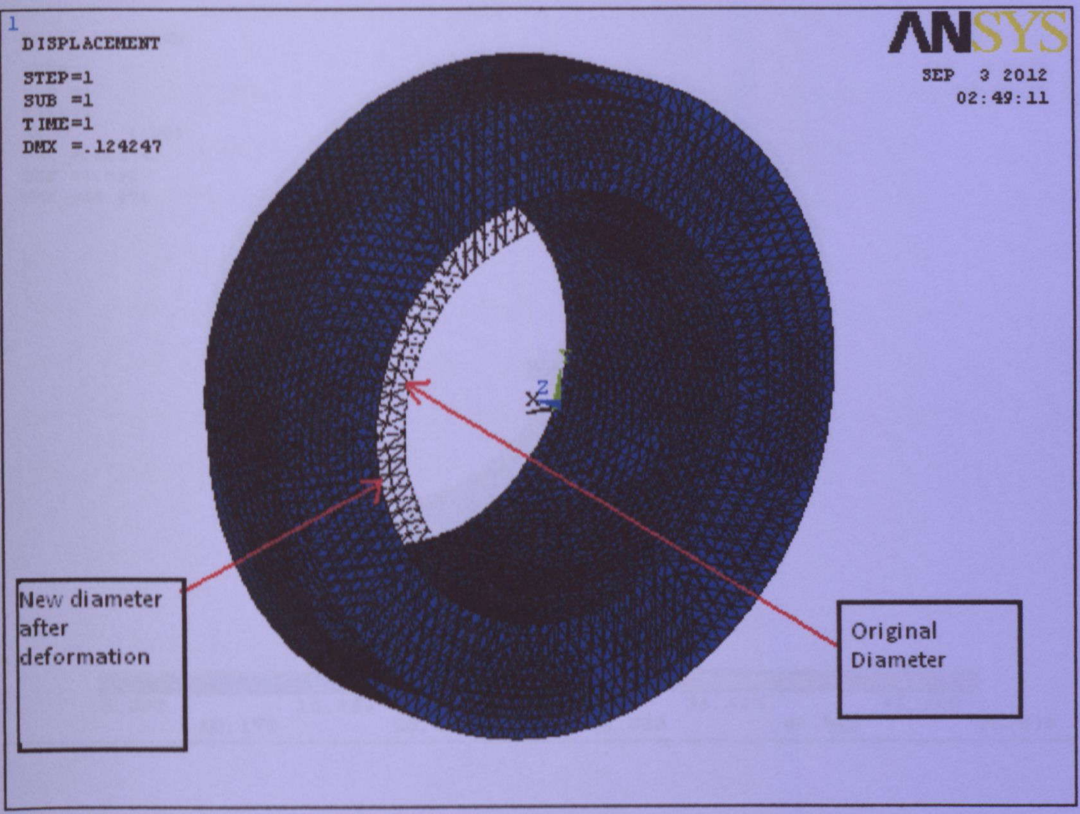


Figure 24: Seat Deformation

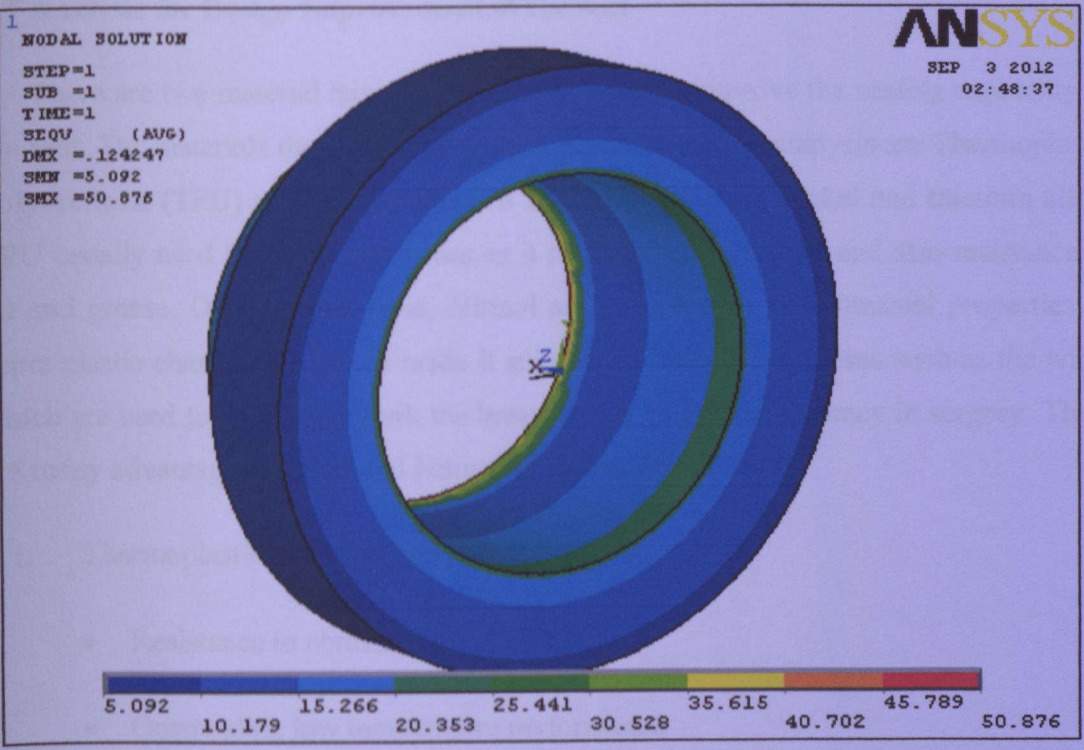


Figure 25: Von Misses stress of the seat

4.5 Analysis for Design Improvement of the seat

There are two material have been tested in order to improve the sealing capability of the seat. The materials that been tested using Static Structural analysis are Thermoplastic Polyurethane (TPU) and Nitinol which is the combination of nickel and titanium alloy. TPU usually used for pipes and hoses as it resistance to abrasion and also resistance to oil and grease. On the other hand, Nitinol are the material with unusual properties. It super elastic characteristic have made it suitable for medical purposes such as the wires which are used to locate and mark the breast tumor to get the accuracy in surgery. There are many advantages of TPU and Nitinol as shown below:

i. Thermoplastic Polyurethane (TPU) Features:

- Resistance to abrasion
- Outstanding low temperature performance
- High shear strength
- High Elasticity
- Good oil and grease resistance

ii. Nitinol (Nickel and Titanium alloy) Features:

- Super elastic material
- Biocompatibility and corrosion resistance
- Can withstand high temperature

* Static Structural analysis parameters

Material	Thermoplastic Polyurethane (TPU)	Nitinol
Young's Modulus	27 MPa	83000 MPa
Poisson Ratio	0.45	0.33
Seat Diameter	6mm	6mm
Pressure Subjected	1000 psi @ 6.9 MPa	1000 psi @ 6.9 MPa

Based on the result obtained, Nitinol had less deformation compared to TPU and also PTFE. The maximum deformation occurred when 1000 psi pressure subjected, it only deformed about 0.000698 which is far better compared with the original seat material which is PTFE. Based on the this analysis only, we can determined that Nitinol is the suitable material to replace PTFE in constructed the seat for ball valve as it had super elastic characteristic that will decreased the seat leakage due to deformation.

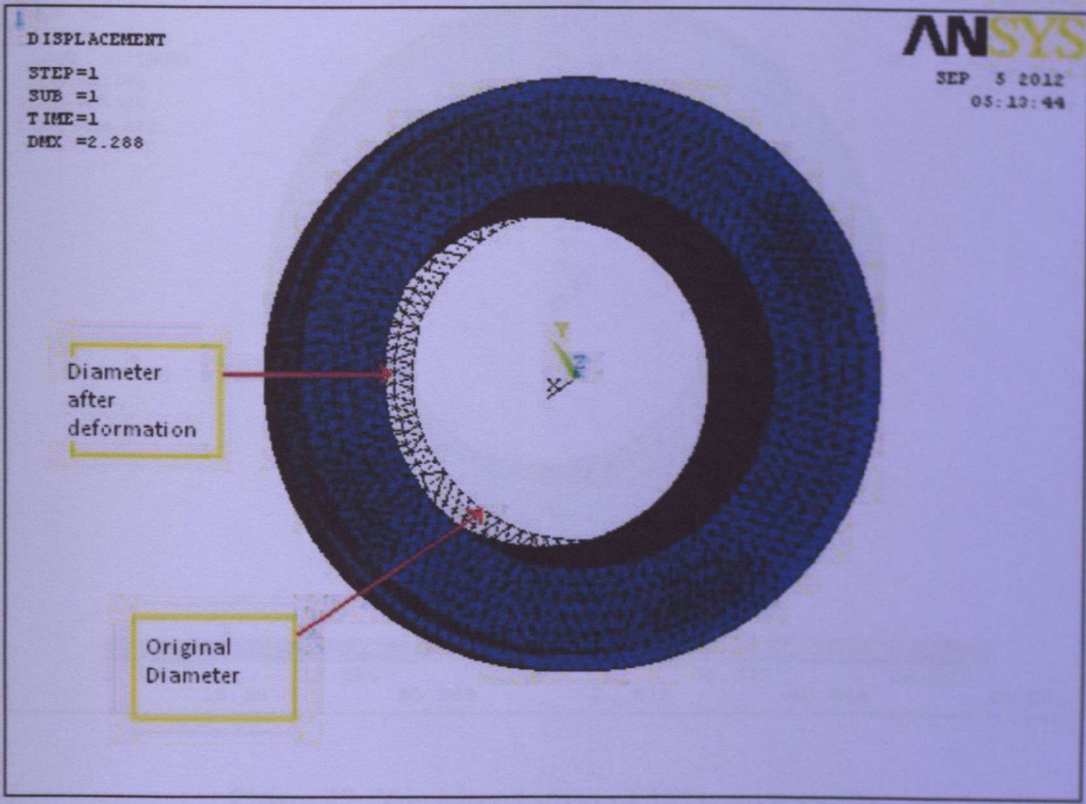


Figure 26: Deformation of TPU seat material

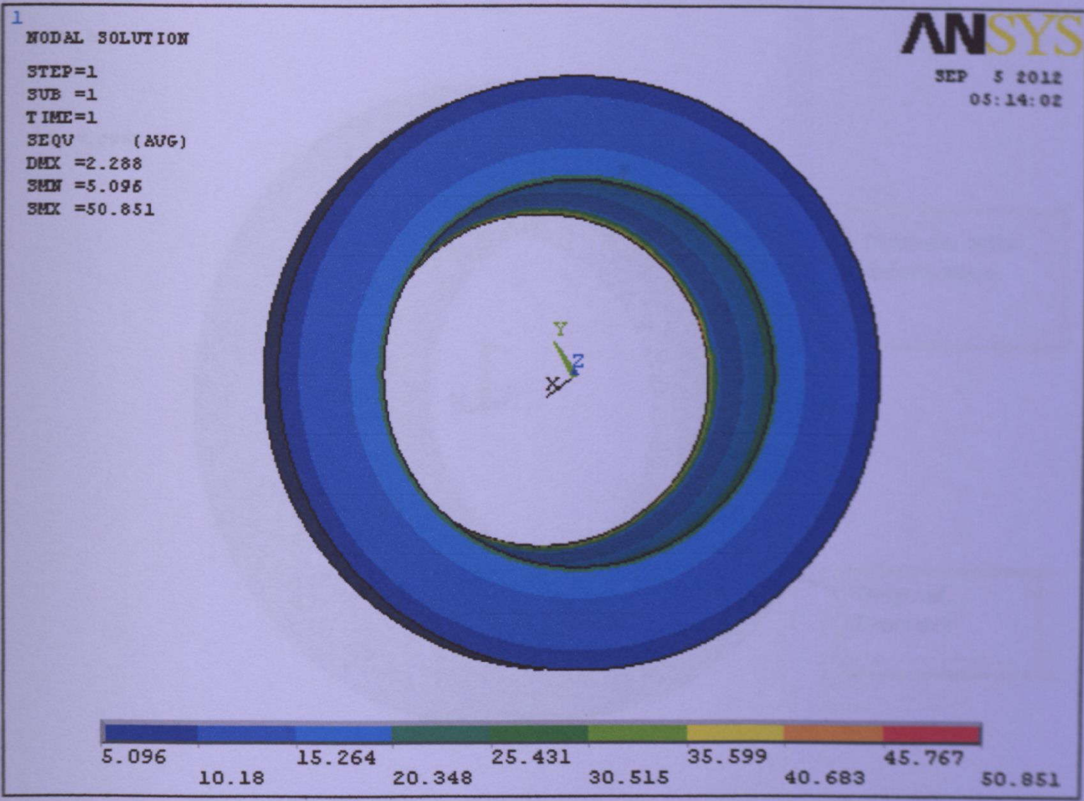


Figure 27: Von Misses stress of TPU seat material

Another solution to overcome the valve leakage due to seat failed to give sealing capability is by design the two layer seat. The first layer will used to hold the ball inside the valve to give the sealing capability as the other layer will acts as redundant in case the first layer is failed to give sealing capability to the ball. By this way, the valve will still operate with optimum performance. Figure 29 until 32 has shown the Static structural result of the double layer seat. Although the deformation are slightly higher from the single layer seat that were used in the original design, but it will affecting the performance of ball valve to operate. The ball valve still can operate even though the first layer of the seat failed due to damages as the other layer will gives the sealing capability to the valve.

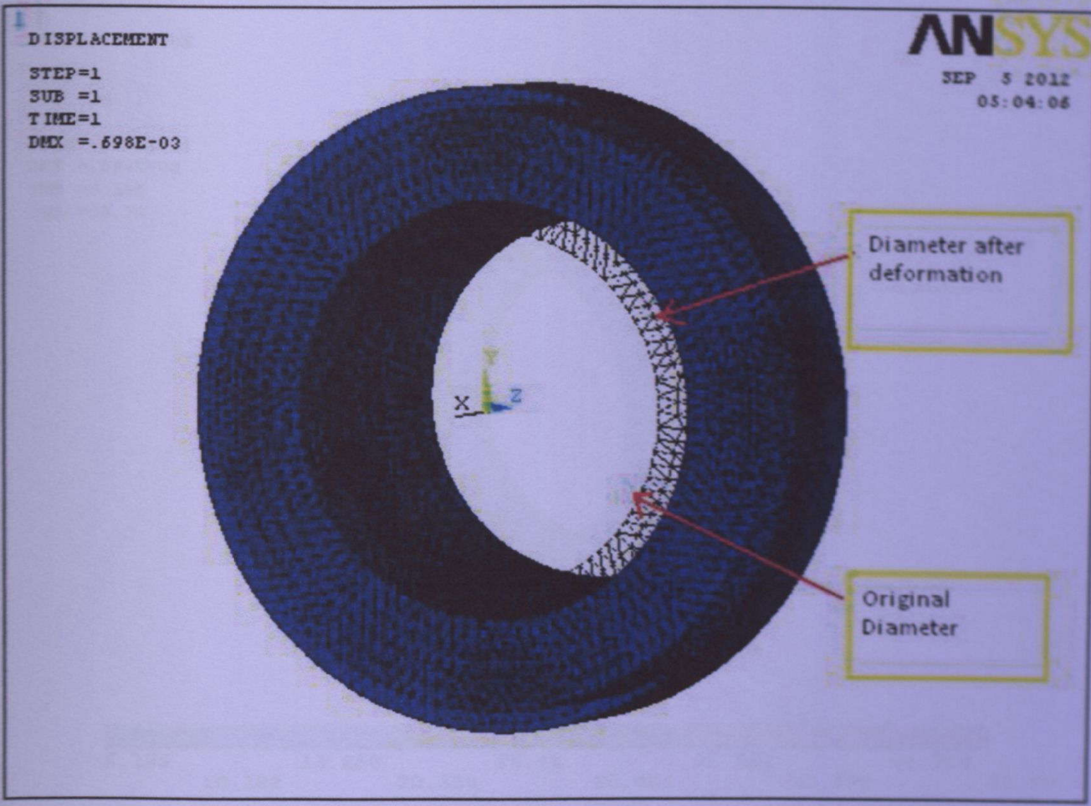


Figure 28: Deformation of Nitinol seat material

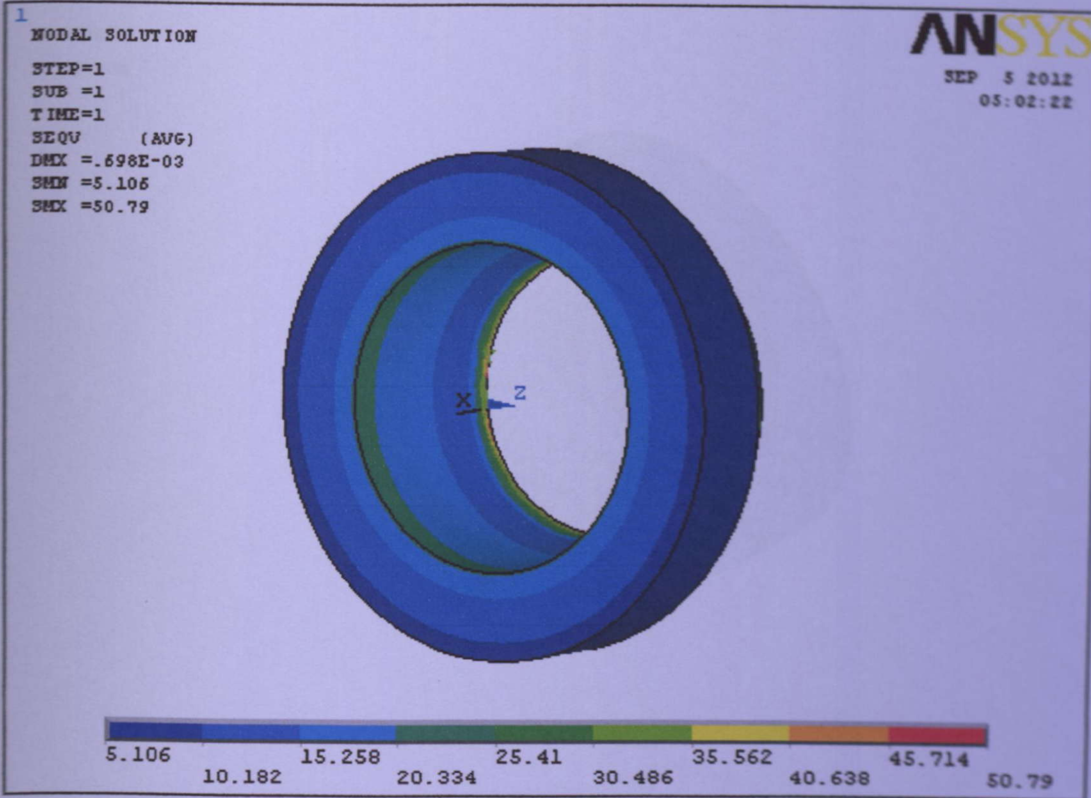


Figure 29: Von Misses stress of Nitinol seat material

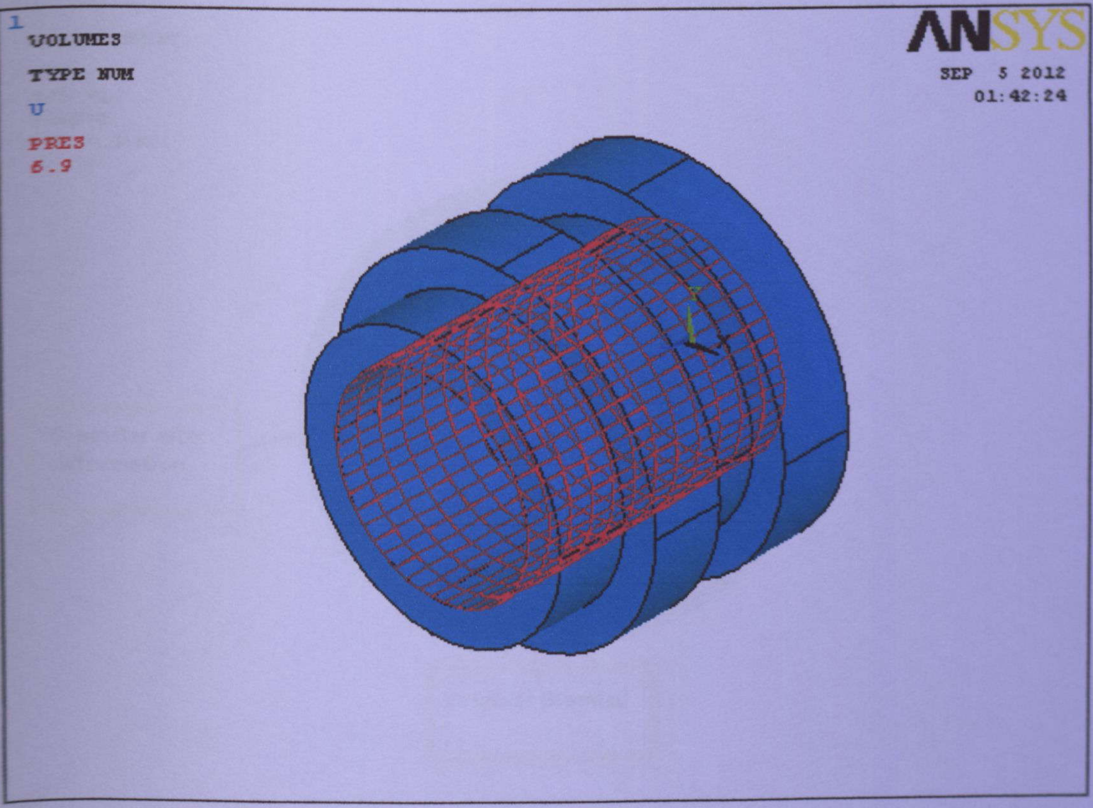


Figure 30: Resulted pressure to the double layer seat

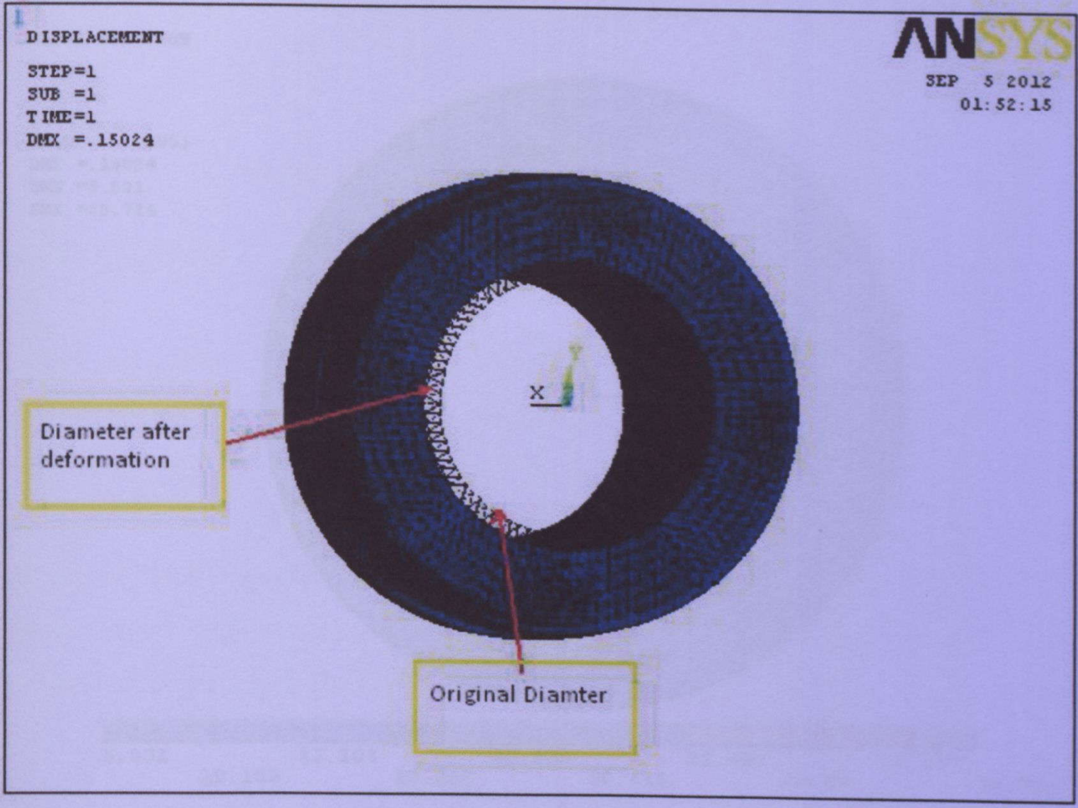


Figure 31: Deformation of double layer seat

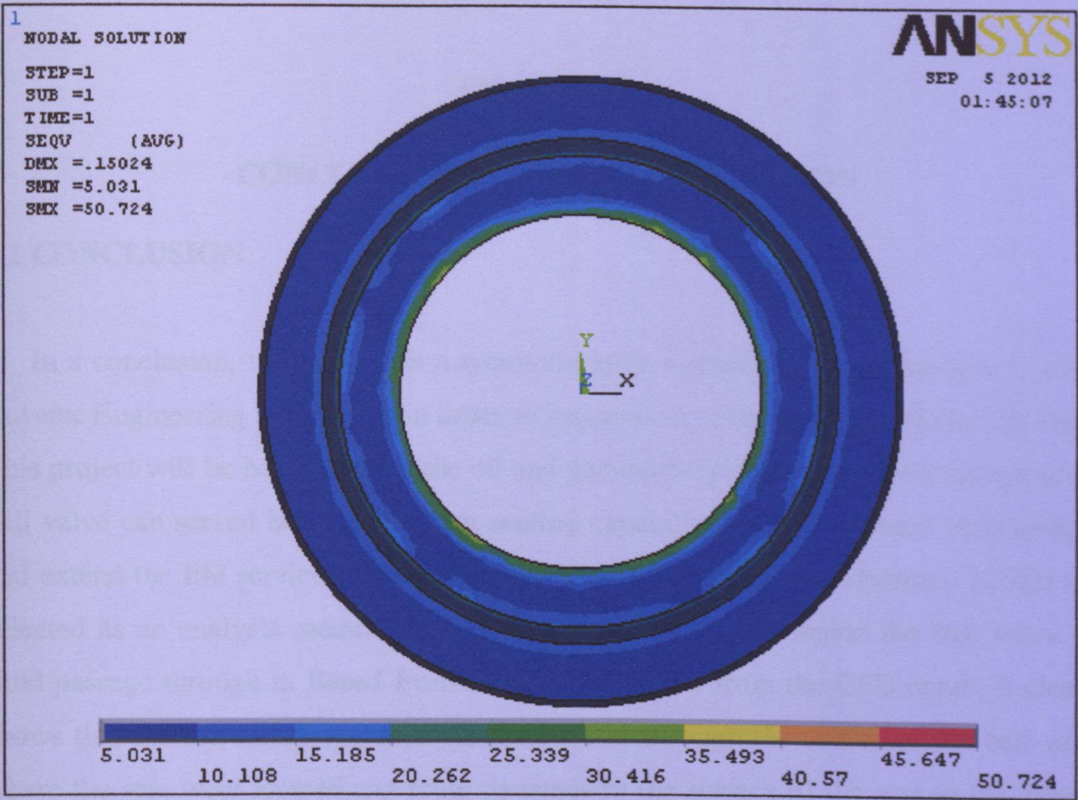


Figure 32: Von Misses stress of double layer seat

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

In a conclusion, this project is a comprehensive research study about how to adapt Reverse Engineering technology in order to improve an existing design of the ball valve. This project will be beneficial for the oil and gas industry as the improved design of the ball valve can served better with great sealing capability that can prevent fluid leakage and extend the life service of the ball valve. Computational Fluid Dynamic (CFD) was selected as an analysis method to determine the flow profile inside the ball valve the fluid passage through it. Based from the result obtained from the CFD result, it clearly shows that the increasing speed as the fluid travel through the orifice of the ball valve where the seat were located can bring damages to the surface of the seat as the erosion occurred. The repeatable impingement of high velocity fluid that contained particle can bring damages to the surface of the seat that reduced the life services and also potentially caused a leaking as the sealing capability has been reduced. This problem can be overcome by using different type of material to construct a seat that can withstand high velocity fluid impact. The double layers seat also can be used to overcome the seat damages. The first layer of the seat will used to hold the ball and the other layer will used as redundant in case the first layer of the seat failed to give the sealing capability. Overall, the objectives of this project have been successfully achieved within the time frame given. Reverse Engineering technology have been proved that the analysis and improvement can be done less in time compared to conventional engineering method where starts again from the conceptual design.

5.2 RECOMMENDATIONS

For a suggested future work, another simulation on the ball valve seat can be done in order to validate further the simulation result obtained from this simulation. Comparable studies between the result obtain from the actual experiment in the laboratory and the result obtain the simulation is highly recommend as the validation work can be more accurate.

REFERENCES

1. DOE-HDBK-1018/2-93; VALVE FUNCTIONS AND BASIC PARTS, http://www.gidb.itu.edu.tr/staff/sogut/den322/Notes/Valves.pdf ; Viewed on 28/02/2012
2. R.W.Zappe, Valve Selection Handbook, Fourth Edition, (1999) pp 11-14
3. Vinesh Raja and Kiran Jude Fernandes, Reverse Engineering : An Industrial Perspective, (2008) pp 2
4. H.A. Khalili, A. Maleki, and S.Ayatollahi, Using Combination of Reverse Engineering and Value Engineering for Improvement in Designs, Construction Projects and Manufacturing Industries, in Proceedings of the 41st International Conference on Computers & Industrial Engineering.
5. Vàrady. T, Martin. R & Cox. J, (1996), Reverse Engineering of geometric models–an introduction. Computer Aided Design,
6. Point Cloud, http://en.wikipedia.org/wiki/Point_cloud; Viewed on 28/02/2012
7. W. B. Thompson, H. J. de St. Germain, T. C. Henderson, J. C. Owen, and S. R. Stark, Feature- Based Reverse Engineering of Mechanical Parts, *IEEE Transactions on Robotic and Automation, Vol. 15* (1999)
8. The VIUscan™ 3D Laser Scanner, http://www.creaform3d.com/en/handyscan3d/products/viuscan.aspx?ic=h3d+link&ie=request+information+viuscan; Viewed on 09/03/2012
9. Vàrady. T, Martin, R, & Cox, J. (1997). Reverse Engineering of geometric models–an introduction. Computer Aided Design, Vol. 29, No. 4, pp. 255-268, ISSN 0010-4485

10. I. Budak, M. Sakovic, J. Kopac, and J. Hadolic, Point Data Pre-Processing Based on Fuzzy Logic for Reverse Engineering Modelling, Journal of Mechanical Engineering (2009)
11. M. Salman A. Mansor, Free-Form Surface Models Generation Using Reverse Engineering Technique- An Investigation
12. M. Rahayem, An Industrial Robot as Part of an Automatic System for Geometric Reverse Engineering
13. R.W.Zappe, Valve Selection Handbook, Fourth Edition, (1999) pp 101-112